

**SANITARY SEWER EVALUATION REPORT  
PHASE I**

**NAVAL AIR STATION - JRB  
FORT WORTH, TEXAS**

PREPARED FOR

**SOUTHERN DIVISION  
NAVAL FACILITIES ENGINEERING COMMAND**  
CONTRACT NO. N62467-92-D-1012

PREPARED BY



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<b>Appendix Number</b>	<b>Description</b>
A	Manhole Inspection Sheets
B	Smoke Testing Forms
C	Sewer System One-Line Diagram

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## 1.0 INTRODUCTION

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Metcalf & Eddy (M&E) was retained by the Department of the Navy, Southern Division Naval Facilities Engineering Command, to perform Phase I of a sanitary sewer infrastructure evaluation at the Naval Air Station JRB Fort Worth, TX (NAS JRB Fort Worth). This Report summarizes the Phase I inspection activities completed, provides an evaluation of the inspected wastewater structures, and recommends a rehabilitation program for the NAS.

### 1.1 Purpose of Study

The purpose of the sanitary sewer infrastructure evaluation is to verify the condition of the sanitary sewer collection system and to identify sources of infiltration and inflow (I/I) and structural deficiencies which when repaired could improve the performance and reliability of the wastewater collection system. The identified defects were evaluated and a rehabilitation program is recommended based on the evaluations performed. Cost estimates for the repair of system defects are included with the recommended rehabilitation program. Recommendations to eliminate other sewer system problems such as conditions causing restrictions of flow are also addressed.

Wastewater collection systems in which extraneous flows (groundwater seepage or infiltration, and storm water sources or inflow) are either excluded or held to a minimum have recognizable benefits. These benefits would include:

- No overloaded or surcharged sewers as a result of extraneous flows (I/I) and the associated problems of wastewater backups and overflows.
- More efficient operation of wastewater treatment facilities.
- The use of the sewer hydraulic capacity for wastewater instead of infiltration/inflow.

The less apparent but usually more significant benefit of a leak-free or “tight” wastewater system can be lower overall capital and operating costs. Savings in costs result from:

- Extended life of existing system components.
- Smaller future expansions of hydraulically sized components, such as sewers, pumping stations, and wastewater treatment processes.
- Lower operating costs realized by a decrease in energy requirements (pumping) and certain chemicals.

## 1.2 Infiltration/Inflow Definitions

To understand the terms used in this report, definitions of infiltration and inflow are presented in the following paragraphs:

### *Infiltration*

This consists of groundwater entering a sewer system, through such means as defective pipes, pipe joints, connections, or manhole walls. Infiltration does not include, and is distinguished from, inflow.

### *Steady Inflow*

This includes the water discharged from foundation drains, and drains from springs and swampy areas.

### *Direct Inflow*

This consists of those types of inflow that have a direct storm water runoff connection to the sanitary sewer and cause an almost immediate increase in wastewater flows during rainfall events. Possible sources are roof leaders, yard and area drains, manhole covers that are subject to sheet flow or ponding, cross connections from storm drains and catch basins, and combined sewers.

### *Delayed Inflow*

This consists of storm water runoff that may require several days or more to drain through the sewer system. This category of inflow can include the discharge of sump pumps from steady inflow as well as the slowed entry of surface water through manholes in ponded areas.

### *Total Inflow*

This is the sum of the direct inflow at any point in the system plus any flow discharged from the system upstream through overflows, pumping station bypasses, and the like.

## 1.3 Visual Inspections

Visual inspections of the sanitary sewer collection system were performed to verify its condition and to identify and quantify sources I/I as well as to evaluate the physical condition of the sanitary sewer collection system. The Phase I visual inspections consisted of the following:

### 1. Manhole Inspections

## 2. Smoke Testing

Flow and rainfall monitoring was not conducted as part of the scope of this study. All manhole inspections were videotaped. A copy of all video tapes are included with this report. Inspection data sheets which document the field data collected during the manhole inspections, and smoke testing are included in Appendices A and B respectively.

The Phase II inspection program consists of cleaning and televising sanitary sewers identified as needing either cleaning or televising during the Phase I inspections. The Phase II results are not part of this report.

### 1.3.1 Project Start-Up

An existing sanitary sewer collection system one-line diagram was provided by NAS JRB Fort Worth Public Works. The diagram included information on lift station locations, manhole locations, and line segment diameters. Manhole identification numbers are shown on the one-line diagram. However these identification numbers are not stamped on the manhole rims or covers. The diagram provided by NAS JRB Fort Worth does not reflect changes due to recent growth and new construction at the base. As a result, manholes were found during the visual inspections that were not shown on the diagram provided. The approximate location for these manholes have been added to the one-line diagram.

### 1.3.2 Manhole Inspection

This task consisted of visually examining the interior and exterior condition of each manhole in the sanitary sewer collection system. The manholes were evaluated for structural integrity, including but not limited to the manhole cover, O-ring and frame, ladder rungs, cones, riser, shelf, and channel. The manhole trench was examined for silt buildup, which could be indicative of infiltration of groundwater into the sewer system. The inspections also included visually examining the elevation of the manhole cover relative to the surrounding territory. This was to determine if the manhole is subject to sheet flow or ponding, which is a source of inflow. An interior and exterior video of each manhole was obtained. Manholes that were buried under less than 12-inches of dirt or 2-inches of asphalt were uncovered, unless otherwise stated. If a manhole was buried deeper than the above or if it was found to be corroded shut or otherwise not accessible, NAS JRB Fort Worth Public Works was notified and the manhole was not inspected. The locations of the manholes inspected are shown on the sewer system one-line diagram included in Appendix C.



### **1.3.3 Smoke Testing**

Smoke testing is cost-effective for locating sources of inflow (as opposed to infiltration) into the system. This task consisted of smoke testing the entire gravity sewer collection system. Smoke testing was performed under dry weather conditions to allow maximum detection of I/I sources. A non-toxic smoke was introduced into the sanitary sewer system at various manholes while the nearby area was observed for evidence of smoke emissions. One-line diagrams prepared by the smoke testing crew, photos of smoke leaks in the system and the estimated lengths of sewer pipe smoke tested are included in Appendix B.

## **1.4 Analysis**

After the completion of the field inspection tasks, the collected field data were reviewed and a recommended rehabilitation program was developed. The analysis also includes cost estimates for improving the structural integrity and the condition of the sanitary sewer collection system.

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## 2.0 INSPECTION RESULTS

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The results of the inspections performed at NAS JRB Fort Worth are included in this section. Tabulations of any structural defects found and problems observed that were discovered during the inspection of the sanitary sewer infrastructure are provided. Inconsistencies observed during field investigations on the wastewater collection system one-line diagram have been noted in this section. Copies of the manhole inspection sheets are included in Appendix A, and all smoke testing forms, in Appendix B. Also, copies of the video tape recordings of the manhole inspections are included with this report.

### 2.1 Manhole Inspections

Manhole inspections were performed to verify manhole locations, pipe size, pipe materials, line segment continuity, and to identify structural defects and sources of I/I. The information obtained during the inspection program was used to develop the recommended rehabilitation program. A summary of the status of each manhole inspected is provided in Table 2.1.1.

Attempts were made to locate and inspect all manholes in the sanitary sewer system. The manhole inspection procedure included recording the following observations:

1. Condition of frame alignment, seal, and evidence of inflow at the frame.
2. Corbel construction, condition, and evidence of inflow.
3. Wall construction, condition, and evidence of infiltration.
4. Bench/trough construction, condition, deposition, and evidence of infiltration.
5. Potential for ponding over manhole cover.
6. Cover type, fit, description, segment length, distance above or below grade, and evidence of inflow.
7. Frame data.
8. Pipe seal condition and evidence of infiltration.
9. Condition of steps.
10. Surcharging or evidence of surcharging.
11. Indication of groundwater level.
12. Depth from manhole rim to pipe inverts.
13. Gas levels inside each manhole.

Before the manhole inspections began, NAS JRB Fort Worth estimated that the sanitary sewer collection system consisted of an estimated 225 manholes. The estimate was based on the number of manholes shown on the one-line diagram of the sewer system provided by NAS JRB Fort Worth. During the manhole inspection program, 282 manholes were identified in the collection system. The additional manholes were found

in areas where construction had occurred since the last time the one-line sewer diagram had been updated.

**TABLE 2.1.1 MANHOLE INSPECTION SUMMARY**

	<b>Quantity</b>
Total Number of Sanitary Sewer Manholes Identified	282
Number of Sanitary Sewer Manholes Inspected	256
Sanitary Sewer Manholes Unable to Locate (UTL)	14
Sanitary Sewer Manholes Buried Under Asphalt	4
Sanitary Sewer Manholes Unable To Open (UTO)	6
Sanitary Sewer Manholes with Active of Surcharging	31
Sanitary Sewer Manholes with Active of Infiltration	3
Sanitary Sewer Manholes with Evidence of Past Infiltration	5
Sanitary Sewer Manholes with Evidence of Inflow	5
Sanitary Sewer Manholes Converted to Lift Stations	2
Sanitary Sewer Manholes that have been Relocated	2
Sanitary Sewer Manholes with Wall Staining	2
Sanitary Sewer Manholes with Tracing Wire in Flow Trough	28
Sanitary Sewer Manholes Requiring Further Inspection	11
Sanitary Sewer Manholes with Signs of Surcharging in Past	8
Sanitary Sewer Manholes that Appear to be Out of Service	9

Of the 282 manholes identified, 4 were found to be buried under asphalt, 14 could not be located, 2 appear to have been relocated, 6 were corroded shut and could not be opened, 9 appear to be out of service, 2 have been converted to lift stations, 2 covers are labeled storm sewer (MH 26H, 26J), and 54 manholes were found that were not on the one-line diagram.

The extra manholes found during inspections were numbered in accordance with the current system as closely as possible. Currently the manholes are not labeled with an identifying number. It is recommended that a metal stamp or welded label be installed on the manhole frame as a means to identify the structure.

At the time of the manhole inspections, the Fort Worth area was undergoing one of its hottest, driest seasons on record. As a result, only 3 manholes showed definite signs of infiltration during the inspections. This made it difficult to positively identify infiltration sources.

The 4 manholes buried under the asphalt are identified on the sewer diagram in Appendix C. At the time of discovery, they were reported to the public works staff. After discussing this with NAS JRB Fort Worth personnel, it was decided not to dig these manholes up for the following reasons:

- The manholes are located in either roads or parking lots that are frequently used.
- The depth below the surface is unknown and substantial excavation might have been necessary to locate them.
- The removal of asphalt would result in a possible safety issue.
- Because of the age of the sewers on the one-line diagram, it is possible that these manholes no longer exist.
- Following the recommended sewer televising, better information will exist to locate these manholes.

There are 31 manholes in which the sewer pipes were observed to be operating under surcharged conditions. There are several reasons which could cause the surcharged conditions, including pipe sags, improper vertical alignment of the sewer pipe, and solids deposition or debris in the sewer system. The major cause of surcharging in this system appears to be the result of solids deposition and debris. Cleaning and televising of the sewer system has been recommended to address this problem.

There are 14 additional manholes that could not be located. In most cases, evidence from the visual inspections indicate that they exist. In most cases, the upstream and downstream manholes were located. Therefore, the manhole has either been removed,

or is buried. Information obtained during the cleaning and televising will allow NAS JRB Fort Worth to determine the status of these manholes. A summary of the manholes that were not found during the field inspections is provided in Table 2.1.2.

**TABLE 2.1.2 MANHOLES NOT INSPECTED**

<b>Manhole No.</b>	<b>Comments</b>
44	Unable to Locate (UTL)
9B	Unable to Locate (UTL)
19-1A	Unable to Locate (UTL)
15D2	Unable to Locate (UTL)
15C	Unable to Locate (UTL)
72	Unable to Locate (UTL)
18B	Unable to Locate (UTL)
10	Unable to Locate (UTL)
13F	Unable to Locate (UTL)
B3A	Unable to Locate (UTL)
B6D1	Unable to Locate (UTL)
B4B	Unable to Locate (UTL)
15E12	Unable to Locate (UTL)
134	Unable to Locate (UTL)
49A	Unable to Open (UTO)
15E4A	Unable to Open (UTO)
114	Unable to Open (UTO)
68	Unable to Open (UTO)
2	Unable to Open (UTO)
3	Unable to Open (UTO)
45	Under Asphalt
46	Under Asphalt
15G3	Under Asphalt
15G2	Under Asphalt
E3	Unable to Access

During the field inspections, 9 of the inspected manholes appeared to be out of service. In most cases, this was determined due to the large build up of deposition within these manholes and also because these manholes were dry. NAS JRB Fort Worth personnel should verify if these manholes are in service.

When the manholes downstream of MH B11 were inspected, a strong hydrocarbon type odor was noticed. This segment of the sewer system is located near the bulk fuel storage tanks. This odor was not noticed in other areas of the collection system. As

the inspections continued downstream, the odor varied in strength. At the end of the line (city outfall) the odor was still present. However, when testing the atmosphere in these manholes, the gas analyzer used did not register high levels of combustibles. However, the gas analyzer used was only able to detect methane. Therefore, NAS JRB Fort Worth should consider testing the atmosphere in these manholes to determine if other hydrocarbons are present. Also, samples of the wastewater in this sewer segment should be collected and analyzed for total petroleum hydrocarbon (TPH).

Manhole construction type within the study area consists roughly of 60 percent brick manholes and 40 percent precast concrete sections. More than 80 percent of the manhole covers were 24-in. in diameter. Several of the manholes have some type of ladder rungs in the walls. The majority of these rungs were observed to be in fair to poor condition.

There were three types of pipe materials encountered during the manhole investigation. The majority of the piping is vitrified clay, ranging from 4-in. diameter to 12-in. diameter. PVC pipe was also noticed in the same diameter range as the vitrified clay. Reinforced concrete pipe (RCP) ranged from 4-in diameter to 8-in. diameter.

A summary of the manhole defects identified is given in Table 2.1.3. Video images of each defect are included in Appendix A. The video tapes provided contain more detail if additional information is desired.

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**TABLE 2.1.3 MANHOLE DEFECTS IDENTIFIED**

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<b>Defect Type</b>	<b>No. of Manholes</b>
Damaged Cover	9
Damaged Frame	9
Misaligned Frames	32
Rusted Ladder Rungs	200
Missing Grout Around Pipe Connection	39
Depressed Frame and Cover (Dirt)	14
Depressed Frame and Cover (Under Asphalt)	4
Open Precast Joints	5
Defective Grout Brick Joints	9
Roots Growing in Manhole	1
Defective Precast Manhole Walls	6
Manholes with Tracing Wire in Flow Path	28

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## **2.2 Smoke Testing**

Smoke testing is a relatively inexpensive method for detecting infiltration and inflow sources in a sewer system. The method is effective in detecting inflow sources such as roof downspouts, yard and area drains, abandoned building sewers, faulty connections, direct connections, and storm sewer cross connections. It can also be utilized to detect structural damage, leaking joints in sewer pipes, and overflow points in the sewer system. A summary of the smoke testing results is provided in Table 2.2.1.

Smoke testing in the sanitary system consisted of forcing smoke in each sewer section and observing the appearance of smoke along the section. A gasoline-powered blower was used to force a high concentration of smoke into each sewer section. Prior to testing, building managers in the area of the smoke testing were notified. The NAS

JRB Fort Worth Fire Department and Security Department were also notified. During testing, observations were recorded for each line segment as follows:

1. Location of line segment.
2. Location of observed smoke leaks.
3. Location of smoke along main sewer line.

Because of varying soil and groundwater conditions, results from smoke testing should be analyzed carefully. Positive findings during the testing definitely indicates the existence of infiltration/inflow sources, however, negative findings may not mean that I/I sources do not exist. In general, smoke rising from curbs, sidewalks, or from the front, side, or rear yard of a building indicates a building lateral source of infiltration. Smoke from a downspout confirms a downspout connection. Sewer main defects are indicated by smoke rising alongside a sewer main line. Smoke observed from a storm system may indicate a direct or indirect cross connection between the storm sewer system and the sanitary sewer system.

At NAS JRB Fort Worth, the smoke testing revealed 30 leaks from around manhole frames. This corresponds closely with the number of frame seal defects observed during the visual manhole inspections. There were 13 leaks noticed due to broken or missing service clean-outs. Also, 4 leaks were identified to be cracks in the service laterals. An additional 4 leaks were observed to be coming from a breach in the main sewer line. Crushed pipe, differential settling, and defective pipe joints are all potential reasons for these leaks. The defects contributing to these leaks will be identified during sewer televising. All of the leaks found during smoke testing (51) represent potential sources of inflow/infiltration. The total length of pipe that was smoke tested was documented to be 52,796 LF.



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**TABLE 2.2.1 SMOKE TESTING RESULTS**

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<b>Leak Description</b>	<b>Quantity</b>
Leaks From Manholes	30
Leaks From Service Clean-Outs	13
Leaks From Defective Service Laterals	4
Leaks From Defective Sewer Mains	4

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### **2.3 Sewer Lamping**

Several attempts were made to lamp the sewer lines at various locations throughout the base, but all proved to be unsuccessful. In small diameter sewers, lamping has limited use. A slight deflection, sag, or deposition build up in an otherwise open sewer will block the light source making it non-detectable at the other manhole. Since the majority of the sewers at NAS JRB are within the 6-in to 10-in diameter range, and are older, vitrified clay type sewers, these negative results are not unexpected. The recommended cleaning and televising will provide an accurate inspection of the sewer lines.

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### 3.0 RECOMMENDED REHABILITATION

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The recommended rehabilitation program described in this section is based on the manhole inspections and the smoke testing results that identified I/I sources and structural defects in the sanitary sewer system. The overall effectiveness of the rehabilitation program is influenced by the types of defects identified and the method of repair employed. The total cost of the rehabilitation program is estimated to be \$200,300.

#### 3.1 Manhole Rehabilitation

Of the 256 sanitary sewer manholes accessible for inspection, 359 defects were observed. A recommended repair procedure has been identified for each defect. Table 3.1.1 is a summary of field notes, defects, defect repair procedures and overall condition of the manholes. Defect repairs and comments are identified in Table 3.1.1 with the use of numbered legends. The numbered legends are included with the manhole inspection and repair summary table. The column labeled "Video" corresponds to the tape number and time location on a video tape where the video clip can be found for each manhole. (Example: 3-0.12.05 translates to tape #3, 0-hours 12-minutes, 5-seconds.)

**TABLE 3.1.1 MANHOLE INSPECTION AND REPAIR SUMMARY**

MH #	VIDEO	DEFECTIVE FRAME AND COVER	DEFECTIVE CHIMNEY	DEFECTIVE LADDER RUNGS	DEFECTIVE WALLS	DEFECTIVE MH JOINTS	DEFECTIVE PIPE JOINTS	DEFECTIVE MH BASE	COMMENT S
56	1—0	2							8,9
56A	1-0.1.50								8,9
55	1-0.3.51								Later in table
54	1-0.4.19	2							8,9
53	1-0.6.37								6
52	1-0.9.59								1,9
55A	1-0.12.55								7
51	1-0.14.22								1
50	1-0.17.12	2							9
49	1-0.20.15								1
49A	1-0.23.15	3							4
49B	1-0.25.44								9
48	1-0.27.31	3,6							9
47	1-0.30.21	1,2,6							9
42	1-0.33.12	3,6			9				
43	1-0.37.44					7			9
45	1-0.40.22								2
46	1-0.40.41								2
44	1-0.40.58								15
4142A	1-0.41.09								1
4142B	1-0.42.16				14		5		6
A9	1-0.45.43								1
41	1-0.46.59								10
11D7	1- 0.49.091								1
11D7A	1-0.50.57								7,9
11D6	1-0.52.30								7,9
11D5	1-0.53.59						5		11,12
11D4	1-0.56.52			4(1)					9
11D8	1-0.59.33								1
11LA	1-1.00.31								9
11L	1-1.02.25								1, Note 1
11J	1-1.05.34	8							9, Note 2
11I	1-1.06.49								12
11H	1-1.08.05								1
11G	1-1.08.31								1

**Legend:**Defect Repair Method:

1. Replace Cover
2. Replace Frame
3. Align and Seal Frame (Includes Grouting if Needed)
4. Remove Rusted Ladder Rungs (No. of Rungs In Parentheses)
5. Chemically Grout Around Pipe
6. Install Adjustment Rings
7. Seal Precast Manhole Joints
8. Install Manufactured Frame Seal
9. Chemically Grout Brick Joints (Add Brick if Needed)
10. Adjust Manhole Frame with Excavation
11. Coat Wall with Corrosion Protection
12. Large Debris (Rock/Concrete)
13. Remove Roots
14. Chemically Grout Hole in Manhole Wall

Comments:

1. Good Condition
2. Buried Under Asphalt
3. Converted to Lift Station
4. Unable to Open (UTO)
5. Manhole has been Relocated
6. Wall Staining
7. Hang Tracing Wire Above Flow Line
8. Possible Inflow due to Shifted Frame and Cover
9. Deposition Needs Cleaning
10. Appears to be Out of Service
11. Further Inspection Required
12. Minor Surcharge < 4"
13. Major Surcharge > 4"
14. Signs of Surcharging in the Past
15. Unable to Locate (UTL)
16. Signs of Infiltration in the Past
17. Active Infiltration

**TABLE 3.1.1 MANHOLE INSPECTION AND REPAIR SUMMARY (cont.)**

MH #	VIDEO	DEFECTIVE FRAME AND COVER	DEFECTIVE CHIMNEY	DEFECTIVE LADDER RUNGS	DEFECTIVE WALLS	DEFECTIVE MH JOINTS	DEFECTIVE PIPE JOINTS	DEFECTIVE MH BASE	COMMENT S
11GA	1-1.08.38	3		4(1)					13
11F	1-1.09.24	3		4(2)					
11E	1-1.11.54	3					5		
11D	1-1.14.10			4(3)			5		
11D1	1-1.17.18								12
11D3	1-1.18.56								9,12
11D2	1-1.20.17			4(1)					9
11D1A	1-1.22.12								9
11D1B									15
11DA	1-1.23.26			4(1)			5		9
11C	1-1.25.54			4(4)			5		
11B	1-1.27.08			4(5)					9
11A	1-1.29.42	3		4(4)					
11	1-1.32.18			4(7)	9			12	13
13E	1-1.37.41	3		4(4)					
13D	1-1.39.16								1
13C	1-1.40.25								1
13B	1-1.41.58								9
13A	1-1.44.00			4(1)					9,12
13A1	1-1.45.47								9,14
13A2	1-1.47.41	3		4(4)			5		9,12
13A3	1-1.49.02	3							9,13
26H	2-0.00.06	1,3							1, Note 4
26I	2-0.01.03	3							
26J	2-0.02.06	1,3							Note 5
26G	2-0.03.23								3
25I	2-0.03.46	3							9,12,14
100	2-0.06.12								1
101	2-0.07.44								1
102	2-0.09.09						5,5,5		Note 6
104	2-0.12.03								1
105	2-0.14.18	3							
108	2-0.16.58								9,12
109	2-0.20.11								1
110	2-0.22.24								1
103	2-0.24.11	1							1, Note 7
133	2-0.25.27								9,13
106	2-0.27.08				14,14		5,5		9,11

Legend:

Defect Repair Method:

1. Replace Cover
2. Replace Frame
3. Align and Seal Frame (Includes Grouting if Needed)
4. Remove Rusted Ladder Rungs (No. of Rungs In Parentheses)
5. Chemically Grout Around Pipe
6. Install Adjustment Rings
7. Seal Precast Manhole Joints
8. Install Manufactured Frame Seal
9. Chemically Grout Brick Joints (Add Brick if Needed)
10. Adjust Manhole Frame with Excavation
11. Coat Wall with Corrosion Protection
12. Large Debris (Rock/Concrete)
13. Remove Roots
14. Chemically Grout Hole in Manhole Wall

Comments:

1. Good Condition
2. Buried Under Asphalt
3. Converted to Lift Station
4. Unable to Open (UTO)
5. Manhole has been Relocated
6. Wall Staining
7. Hang Tracing Wire Above Flow Line
8. Possible Inflow due to Shifted Frame and Cover
9. Deposition Needs Cleaning
10. Appears to be Out of Service
11. Further Inspection Required
12. Minor Surcharge < 4"
13. Major Surcharge > 4"
14. Signs of Surcharging in the Past
15. Unable to Locate (UTL)
16. Signs of Infiltration in the Past

17. Active Infiltration

**TABLE 3.1.1 MANHOLE INSPECTION AND REPAIR SUMMARY (cont.)**

MH #	VIDEO	DEFECTIVE FRAME AND COVER	DEFECTIVE CHIMNEY	DEFECTIVE LADDER RUNGS	DEFECTIVE WALLS	DEFECTIVE MH JOINTS	DEFECTIVE PIPE JOINTS	DEFECTIVE MH BASE	COMMENT S
107	2-0.29.02					7,13			16
135	2-0.31.23								9,10
136	2-0.32.47								1
9	2-0.33.57			4(1)					
9A	2-0.35.28			4(3)					9
9C	2-0.37.28	3							9
9B									15
15X	2-0.39.10								1
15W	2-0.39.59	1,2						12	9
15V	2-0.42.30	3							
15U	2-0.44.23								3
15NA	2-0.45.14								1
15MA	2-0.46.44								1
15LA	2-0.51.41								1
15KA	2-0.48.23				14,14				16
15JA	2-0.52.31					7			16
15IA	2-0.55.09								1
15HA	2-0.56.31								1
15GA	2-0.57.43								1,11
15FA	2-0.59.54								1
15EA	2-1.01.51								1
15DA	2-1.02.56								1
15CA	2-1.04.02								1
15BA	2-1.05.03			4(2)	14				
15E11	2-1.07.21			4(4)			5		9,11
15I1A	2-1.10.20								1
15E10	2-1.12.16			4(3)			5		9,11
15E9	2-1.14.35						5,5		9, Note 9
15E8	2-1.17.53						5,5,5		9,11,13, Note10
15E7B	2-1.20.25								1
15E7A	2-1.21.36	1,10							9,12,14
15E7	2-1.24.56								1
15E6	2-1.26.39								1
15E5	2-1.28.25								9,10
15E4	2-1.29.21			4(4)			5		
15E3	2-1.32.27						5		9,13

**Legend:****Defect Repair Method:**

1. Replace Cover
2. Replace Frame
3. Align and Seal Frame (Includes Grouting if Needed)
4. Remove Rusted Ladder Rungs (No. of Rungs In Parentheses)
5. Chemically Grout Around Pipe
6. Install Adjustment Rings
7. Seal Precast Manhole Joints
8. Install Manufactured Frame Seal
9. Chemically Grout Brick Joints (Add Brick if Needed)
10. Adjust Manhole Frame with Excavation
11. Coat Wall with Corrosion Protection
12. Large Debris (Rock/Concrete)
13. Remove Roots
14. Chemically Grout Hole in Manhole Wall

**Comments:**

1. Good Condition
2. Buried Under Asphalt
3. Converted to Lift Station
4. Unable to Open (UTO)
5. Manhole has been Relocated
6. Wall Staining
7. Hang Tracing Wire Above Flow Line
8. Possible Inflow due to Shifted Frame and Cover
9. Deposition Needs Cleaning
10. Appears to be Out of Service
11. Further Inspection Required
12. Minor Surcharge < 4"
13. Major Surcharge > 4"
14. Signs of Surcharging in the Past
15. Unable to Locate (UTL)
16. Signs of Infiltration in the Past
17. Active Infiltration

**TABLE 3.1.1 MANHOLE INSPECTION AND REPAIR SUMMARY (cont.)**

MH #	VIDEO	DEFECTIVE FRAME AND COVER	DEFECTIVE CHIMNEY	DEFECTIVE LADDER RUNGS	DEFECTIVE WALLS	DEFECTIVE MH JOINTS	DEFECTIVE PIPE JOINTS	DEFECTIVE MH BASE	COMMENT S
15E2	2-1.35.33								9,13
15E4A	2-1.37.58								4
15E1	2-1.38.40	3							
15E	2-1.40.06						5		9,11
15G3	2-1.41.08								2
15G2	2-1.41.50								2
15G2A	2-1.42.40						5		9, Notes 11 & 20
15G1	2-1.45.24						5		9
15G	2-1.48.45		9						
15F	2-1.51.32								1
15F1	2-1.52.51	3							
15GX	3-0.0.12								1
15GY	3-0.1.23								1
15GZ	3-0.2.34								1
15G1A	3-0.4.03								1
15H	3-0.5.36		9						9
15I							5		
19-1A									15
19-1	3-0.12.05			4 (7)					9
15D	3-0.14.08			4(7)					9
15D1	3-0.17.55		9						9
15D2									15
15C	3-0.19.54								15
15B	3-0.20.0			4(4)					
19	3-0.21.47			4(1)					9
19A1	3-0.23.27								9
19A2	3-0.25.33								9
19B	3-0.26.50			4(3)					10
112	3-0.28.38								1
124	3-0.30.49								1
125	3-0.32.55								9,13
113	3-0.35.19	1,3							
114	3-0.37.05	3							4
115	3-0.38.04								1
19B1B	3-0.39.38								1
19B1	3-0.41.44	10		4(3)					9,13

**Legend:**Defect Repair Method:

1. Replace Cover
2. Replace Frame
3. Align and Seal Frame (Includes Grouting if Needed)
4. Remove Rusted Ladder Rungs (No. of Rungs In Parentheses)
5. Chemically Grout Around Pipe
6. Install Adjustment Rings
7. Seal Precast Manhole Joints
8. Install Manufactured Frame Seal
9. Chemically Grout Brick Joints (Add Brick if Needed)
10. Adjust Manhole Frame with Excavation
11. Coat Wall with Corrosion Protection
12. Large Debris (Rock/Concrete)
13. Remove Roots
14. Chemically Grout Hole in Manhole Wall

Comments:

1. Good Condition
2. Buried Under Asphalt
3. Converted to Lift Station
4. Unable to Open (UTO)
5. Manhole has been Relocated
6. Wall Staining
7. Hang Tracing Wire Above Flow Line
8. Possible Inflow due to Shifted Frame and Cover
9. Deposition Needs Cleaning
10. Appears to be Out of Service
11. Further Inspection Required
12. Minor Surcharge < 4"
13. Major Surcharge > 4"
14. Signs of Surcharging in the Past
15. Unable to Locate (UTL)
16. Signs of Infiltration in the Past

17. Active Infiltration



**TABLE 3.1.1 MANHOLE INSPECTION AND REPAIR SUMMARY (cont.)**

MH #	VIDEO	DEFECTIVE FRAME AND COVER	DEFECTIVE CHIMNEY	DEFECTIVE LADDER RUNGS	DEFECTIVE WALLS	DEFECTIVE MH JOINTS	DEFECTIVE PIPE JOINTS	DEFECTIVE MH BASE	COMMENT S
19B1C	3-0.43.48								1
67	3-0.45.21								1
68	3-0.46.12								4
69	3-0.46.34								1
70	3-0.47.48	3							8
71	3-0.49.16								1
72	3-0.50.22								15
73	3-0.50.25	10							
74	3-0.52.30	10							
75	3-0.53.59	3							
76	3-0.55.59	2							
77	3-0.58.05								1
78	3-0.59.03								1
18	3-0.59.52			4(6)					1
18A	3-1.01.15						5		9
18B	3-1.03.10								15
18-1	3-1.03.29			4(4)	9		5		9,13, Note13
17	3-1.06.54								9,12
17-1	3-1.08.42			4(5)			5		9,13
16	3-1.10.37			4(9)					9,12
16-1	3-1.12.34			4(4)					9,13
15-1	3-1.13.16								1
15-2	3-1.14.51								1
15-3	3-1.16.49	3							8,9
4E	3-1.19.34			4(3)					9
4D	3-1.20.30			4(8)					
4C1	3-1.24.07								9,10
4B	3-1.26.05			4(3)	9				
79	3-1.28.44	10							14
80	3-1.29.59	10							14
2	3-1.32.32								4, Note 14
3	3-1.32.58								4, Note 14
4	3-1.33.24			4(4)					
5	3-1.35.31	3							
6	3-1.37.09								1
7	3-1.39.20		9				5		11
7A1	3-1.42.37	3							
7A2	3-1.44.12	2							
8	3-1.46.53								1

Legend:

Defect Repair Method:

1. Replace Cover
2. Replace Frame
3. Align and Seal Frame (Includes Grouting if Needed)
4. Remove Rusted Ladder Rungs (No. of Rungs In Parentheses)
5. Chemically Grout Around Pipe
6. Install Adjustment Rings
7. Seal Precast Manhole Joints
8. Install Manufactured Frame Seal
9. Chemically Grout Brick Joints (Add Brick if Needed)
10. Adjust Manhole Frame with Excavation
11. Coat Wall with Corrosion Protection
12. Large Debris (Rock/Concrete)
13. Remove Roots
14. Chemically Grout Hole in Manhole Wall

Comments:

1. Good Condition
2. Buried Under Asphalt
3. Converted to Lift Station
4. Unable to Open (UTO)
5. Manhole has been Relocated
6. Wall Staining
7. Hang Tracing Wire Above Flow Line
8. Possible Inflow due to Shifted Frame and Cover
9. Deposition Needs Cleaning
10. Appears to be Out of Service
11. Further Inspection Required
12. Minor Surcharge < 4"
13. Major Surcharge > 4"
14. Signs of Surcharging in the Past
15. Unable to Locate (UTL)
16. Signs of Infiltration in the Past
17. Active Infiltration

**TABLE 3.1.1 MANHOLE INSPECTION AND REPAIR SUMMARY (cont.)**

MH #	VIEDO	DEFECTIVE FRAME AND COVER	DEFECTIVE CHIMNEY	DEFECTIVE LADDER RUNGS	DEFECTIVE WALLS	DEFECTIVE MH JOINTS	DEFECTIVE PIPE JOINTS	DEFECTIVE MH BASE	COMMENT S
8A	3-1.48.15					7			17
8B	3-1.53.20								7,9
8C	3-1.55.18								7,9,12
8B1	4-0.022								7
8B2	4-0.1.05								7
8B3	4-0.2.25								7
7A	4-0.3.14								9,12
10	4-0.4.56								15
12	4-0.5.34			4(7)					
13	4-0.8.7						5		7,9,12,17
13A5	4-0.10.53						5		
13A4	4-0.12.48								7
13F									15, Note 17
14	4-0.14.11								Note 17
B3B	4-0.15.36	3							
B3C	4-0.16.45								1
B3H	4-0.18.11			4(1)					
B3G1	4-0.19.50								1
B3G	4-0.20.55			4(4)	7				9,17
B3D	4-0.23.49	1,2		4(3)					
B3E	4-0.24.43	2							
B3F	4-0.26.21								1
B3A									15
E7	4-0.27.27								7
E3B	4-0.28.43								1
E3A	4-0.30.33								1
E3A1	4-0.31.12								1
E3A2	4-0.32.28	10							
E4	4-0.33.40								Note 19
E5	4-0.35.44								1
E5A	4-0.36.34								1
E6	4-0.37.11								1
E6A	4-0.38.11								1
E6B									1
E3B1	4-0.40.08								1
E1C	4-0.40.52								1
E1B	4-0.41.33								1
E3A3	4-0.42.22								1
E1A	4-0.42.58								1

**Legend:**Defect Repair Method:

1. Replace Cover
2. Replace Frame
3. Align and Seal Frame (Includes Grouting if Needed)
4. Remove Rusted Ladder Rungs (No. of Rungs In Parentheses)
5. Chemically Grout Around Pipe
6. Install Adjustment Rings
7. Seal Precast Manhole Joints
8. Install Manufactured Frame Seal
9. Chemically Grout Brick Joints (Add Brick if Needed)
10. Adjust Manhole Frame with Excavation
11. Coat Wall with Corrosion Protection
12. Large Debris (Rock/Concrete)
13. Remove Roots
14. Chemically Grout Hole in Manhole Wall

Comments:

1. Good Condition
2. Buried Under Asphalt
3. Converted to Lift Station
4. Unable to Open (UTO)
5. Manhole has been Relocated
6. Wall Staining
7. Hang Tracing Wire Above Flow Line
8. Possible Inflow due to Shifted Frame and Cover
9. Deposition Needs Cleaning
10. Appears to be Out of Service
11. Further Inspection Required
12. Minor Surcharge < 4"
13. Major Surcharge > 4"
14. Signs of Surcharging in the Past
15. Unable to Locate (UTL)
16. Signs of Infiltration in the Past
17. Active Infiltration

**TABLE 3.1.1 MANHOLE INSPECTION AND REPAIR SUMMARY (cont.)**

MH #	VIEDO	DEFECTIVE FRAME AND COVER	DEFECTIVE CHIMNEY	DEFECTIVE LADDER RUNGS	DEFECTIVE WALLS	DEFECTIVE MH JOINTS	DEFECTIVE PIPE JOINTS	DEFECTIVE MH BASE	COMMENT S
E1	4-0.43.42								1
E2	4-0.44.57								1
E3									Note 18
B16	4-0.46.31								9
B15A	4-0.47.57			4(5)					1
B15	4-0.50.06								7,12, Note12
B14	4-0.51.58			4(6)					
B14A									1
B13	4-0.54.25						5		
B13B	4-0.55.58								7
B13A	4-0.57.55								7
B12	4-0.58.47	3					5		7,9,11,13
B12A	4-1.01.37						5		7,9,11,12
B10	4-1.03.50								1
B9	4-1.05.04								1
B9A	4-1.06.21								9,10
B8	4-1.07.35								1
B7A	4-1.09.08	6		4(4)					9
B7A1	4-1.11.13								1,9
B7B	4-1.12.31			4(2)					10
B7A2	4-1.13.14			4(3)					9,10
B7D	4-1.14.13								1
B7E	4-1.16.51								1
B7C	4-1.17.50	10							
B6	4-1.19.57	3							10
B6D	4-1.24.02	3							5
B6D1									15
B5	4-1.16.12			4(6)	9				
B4	4-1.28.12			4(7)			5		
B4B	4-1.30.43								15
B4A	4-1.31.12	8							9,16
B3	4-1.32.24								9,14
B2	4-1.34.03	1							9,13
B1A	4-1.35.51			4(2)					9,14
B6A	4-1.37.55			4(5)					
B6A1	4-1.39.18								1
B6B	4-1.40.16	10		4(2)					9
B6C	4-1.41.48						5		
B7	4-1.43.04			4(3)			5		9

**Legend:**Defect Repair Method:

1. Replace Cover
2. Replace Frame
3. Align and Seal Frame (Includes Grouting if Needed)
4. Remove Rusted Ladder Rungs (No. of Rungs In Parentheses)
5. Chemically Grout Around Pipe
6. Install Adjustment Rings
7. Seal Precast Manhole Joints
8. Install Manufactured Frame Seal
9. Chemically Grout Brick Joints (Add Brick if Needed)
10. Adjust Manhole Frame with Excavation
11. Coat Wall with Corrosion Protection
12. Large Debris (Rock/Concrete)
13. Remove Roots
14. Chemically Grout Hole in Manhole Wall

Comments:

1. Good Condition
2. Buried Under Asphalt
3. Converted to Lift Station
4. Unable to Open (UTO)
5. Manhole has been Relocated
6. Wall Staining
7. Hang Tracing Wire Above Flow Line
8. Possible Inflow due to Shifted Frame and Cover
9. Deposition Needs Cleaning
10. Appears to be Out of Service
11. Further Inspection Required
12. Minor Surcharge < 4"
13. Major Surcharge > 4"
14. Signs of Surcharging in the Past
15. Unable to Locate (UTL)
16. Signs of Infiltration in the Past
17. Active Infiltration

**TABLE 3.1.1 MANHOLE INSPECTION AND REPAIR SUMMARY (cont.)**

MH #	VIEDO	DEFECTIVE FRAME AND COVER	DEFECTIVE CHIMNEY	DEFECTIVE LADDER RUNGS	DEFECTIVE WALLS	DEFECTIVE MH JOINTS	DEFECTIVE PIPE JOINTS	DEFECTIVE MH BASE	COMMENT S
55	4-1.45.24	10							7,16
55B	4-1.46.32								7
55C									7,9,12
55E	4-1.48.44	3							7,9
55D	4-1.50.19	3		4(3)					7,9
4A	4-1.51.32			4(2)					9,12
15	4-1.52.51			4(3)			5		
15A	4-1.54.01			4(4)					
15E11B	4-1.55.27								1
B11A	4-1.56.52								1
11B	4-1.57.40			4(2)					1
9D	5-0.0.09								1,7
9D1	5-0.1.33								1,7
9D2	5-0.3.27						5		7
9D3	5-0.5.29								1,7
9E	5-0.6.52								1,7
9E1	5-0.8.22								7,9,13
9E2	5-0.10.22								7,9
9E3	5-0.11.35								1,9
15E12									15
134									15
4C									1

**Legend:**Defect Repair Method:

1. Replace Cover
2. Replace Frame
3. Align and Seal Frame (Includes Grouting if Needed)
4. Remove Rusted Ladder Rungs (No. of Rungs In Parentheses)
5. Chemically Grout Around Pipe
6. Install Adjustment Rings
7. Seal Precast Manhole Joints
8. Install Manufactured Frame Seal
9. Chemically Grout Brick Joints (Add Brick if Needed)
10. Adjust Manhole Frame with Excavation
11. Coat Wall with Corrosion Protection
12. Large Debris (Rock/Concrete)
13. Remove Roots
14. Chemically Grout Hole in Manhole Wall

Comments:

1. Good Condition
2. Buried Under Asphalt
3. Converted to Lift Station
4. Unable to Open (UTO)
5. Manhole has been Relocated
6. Wall Staining
7. Hang Tracing Wire Above Flow Line
8. Possible Inflow due to Shifted Frame and Cover
9. Deposition Needs Cleaning
10. Appears to be Out of Service
11. Further Inspection Required
12. Minor Surcharge < 4"
13. Major Surcharge > 4"
14. Signs of Surcharging in the Past
15. Unable to Locate (UTL)
16. Signs of Infiltration in the Past
17. Active Infiltration

# Footnotes to Table 3.1.1

Note 1.	MH 11L	The seepage is coming from another service connection.
Note 2.	MH 11J	Install MH frame seal to ensure parking lot run off will not inflow.
Note 3.	MH 11GA	22" of surcharge
Note 4.	MH 26H	Cover mislabeled "storm sewer"
Note 5.	MH 26J	Cover mislabeled "storm sewer"
Note 6.	MH 102	Pipes appear to be slip lined, however the annular space around the pipes was not grouted.
Note 7.	MH 103	Cover problem, will not sit flat, could be a warped cover.
Note 8.	MH 106	Pipes appear to be slip lined, however the annular space around the new pipes was never grouted. Also, holes in the manhole wall near the annular space around the bottom may be the source of the sand build up.
Note 9.	MH 15E9	Pipes appear to be slip lined, however the annular space around the new pipes was never grouted.
Note 10.	MH 15E8	Pipes appear to be slip lined, however the annular space around the new pipes was never grouted.
Note 11.	MH 15G1A	The MH base has an improper service connection. The pipe in MH trough was never cut out.
Note 12.	MH 19A1	The bench shoulders are too shallow. The MH needs concrete fill in the corners to create a proper flow path.
Note 13.	MH 18-1	There is a pipe or a bar protruding through the wall.
Note 14.	MH 2	UTO, MH is raised approximately 10-ft.
Note 15.	MH 3	UTO, MH is raised approximately 10-ft.
Note 16.	MH B15	Defective service connection.
Note 17.		Area under construction.
Note 18.	MH E3	Could not access manhole due to a dog in the yard.
Note 19.	MH E4	Remove large stick.
Note 20.		Appears that manhole has been relocated.

Table 3.1.2 is a rehabilitation cost summary of the recommended improvements to the sanitary sewer system.

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**TABLE 3.1.2 MANHOLE REHABILITATION COST SUMMARY**

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<b>Defect Type</b>	<b>Quantity</b>
Replace Cover	9
Replace Frame	9
Align and Seal Frame	32
Remove Rusted Ladder Rungs	200
Chemically Grout Around Pipe	39
Install Adjustment Ring	4
Seal Precast Joints	5
Install Manufactured Frame Seal	2
Chemically Grout Brick Joints	9
Adjust Manhole Frame with Excavation	10
Raise Manhole Frame (Under Asphalt)	4
Remove Roots	1
Chemically Grout Holes in Wall	6
Remove Top of Pipe	1
Remove Tracing Wire From Flow Path	28

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### **3.2 Sewer Line Rehabilitation**

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Main line sewer repairs are not recommended at this time as a result of the smoke testing and manhole inspections. Sewer line defect rehabilitations will be identified during the recommended televising program.

### **3.2.1 Service Lateral Rehabilitation**

Of the 51 smoke leaks discovered, 17 are related to the service laterals. The majority of the leaks are from defective end caps on the service lateral clean-outs. In order to reduce potential inflow, it is recommended to replace these caps and repair broken riser pipes as applicable. Service laterals are not included in the recommended televising program. Therefore it is recommended to spot repair the 4 defective service laterals with open cut excavation. Table 3.2.1.1 summarizes the cost for these repairs.

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**TABLE 3.2.1.1 SERVICE LATERAL REHABILITATION**

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<b>Defect Type</b>	<b>Quantity</b>
Repair Clean-Outs	13
Repair Service Laterals	4

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### **3.2.2 Sewer Cleaning and Televising**

The sewer system one-line diagram included in Appendix C indicates the recommended areas to be cleaned and/or televised. Those sewers that are recommended for cleaning and televising are highlighted in blue. These sewers appear to be part of the original system and are mostly vitrified clay pipe. The lines that are recommended for televising only are highlighted in green.

The sewer lines not included in the recommended cleaning and televising program appear to be in good condition. The family housing area on the south side of the base appears to have been replaced recently with PVC pipe and precast concrete manholes. Also the Air Force Reserve area (Building Nos. 1643 and 1649) has newer PVC pipe with precast concrete manholes. The area west of the Air Force

Reserve is still under construction, therefore no recommendations have been made regarding this area.

The following list summarizes the size and quantity for the recommended sewer lines to be cleaned and televised.

<b><u>Line Size</u></b>	<b><u>Linear Feet</u></b>	<b><u>Task Item</u></b>
6" Dia.	2,900	Clean and Televis
8" Dia.	34,400	Clean and Televis
12" Dia.	3,650	Clean and Televis
12" Dia.	4,000	Televis Only